Building Coadded Spectra from Single Exposures

Vaishali Bhardwaj

April 16, 2015

1   Introduction

We aim to create coadded spectra from single exposures from the BOSS spectroscopic data. Although the BOSS project delivers its own coadded spectra, this coadd is not up the standards that we require for our 1D power spectrum analysis. The following are problems that would affect our result that we need to eliminate.

- Coadds are created from a spline interpolation which can cause mixing of power and does not ensure an uncorrelated noise estimate.

- Spectrophotometric errors cause the throughput between exposures to be different. The same calibration vector is used on all exposures of one observation in the pipeline and the differences in throughput need to be accounted for.

2   Method

We will create a fixed grid on which to create our coadds defined by the pixel width of the BOSS coadd spectra, namely $\Delta \log_{10}(\lambda) = 0.0001$. For each coadd, we will save a vector of flux values, f_{coadd} inverse variance, v_{coadd}, and resolution, r_{coadd}.

For each quasar, we will create a coadd from all the exposures of all observations of that particular quasar –

- Loop over pixels of all exposures (blue and red)

- For each pixel, pix, compute distance from grid points

- Choose nearest grid point, x:

$$f_{coadd,x} \;\; = \;\; \sum_{i}^{N_{exp}} f_{pix} \tag{1}$$

$$v_{coadd,x} \;\; = \;\; \sum_{i}^{N_{exp}} v_{pix} \tag{2}$$

- Define resolution of pixel. [VB: *We could do a simple average of the resolution from each exposure, which is what the pipeline does, and during our analysis, get rid of quasars with a large variance between resolution per exposure. Therefore, here, we should not only compute the average of the resolution but the variance between exposures as well. Or, is there is a better way to define one resolution value for the coadd?*]

Although the above seems simple enough, the question really is what we're defining as the flux of the coadd. Do we want this coadd to contain *intrinsic* flux coming from the quasar, or the *observed* flux (which would include throughput and sky contribution). One of the advantages of using the individual exposures is to measure a throughput correction, exposure by exposure. Therefore, we should be accounting for this correction to the flux per pixel of an exposure. In this case, for a pixel in an exposure,

$$f_{int,p} = \frac{f_{obs,p} - s_p}{t_p} \tag{3}$$

where $f_{int,p}$ is the intrinsic flux at pixel p, $f_{obs,p}$ is the observed flux, t_p is the single exposure throughput correction and s_p is the additive sky residual, all at pixel p.

In addition, we need to account for the noise variance measured from the single exposures and apply this to our measurement of the inverse variance.

[VB: *With regards to other values we may be interested in and want to save, per quasar, in McDonald 2006, the value of χ^2/ν per pixel was a good predictor of noise mistestimation. χ^2/ν is computed by comparing the coadd flux for each grid point to the contribution given by different exposures.*]

3   Questions

- There is overlap in the wavelength region covered by the red end of the blue spectrograph and the blue end of the red spectrograph. If I remember correctly, the pipeline does some weird average in that region. Either way, how do we plan to deal with this region?

- If writing coadds to disk, what values should be included and what format should we save them in?